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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF HOME ECONOMICS
WASHINGTON, D. C.

ELECTRIC RANGES FOR HOUSEHOLD USE

Trends in Design and Suggestions for Improvement

In order to compare and make a rough evaluation of electrical household ranges now available for use by families of moderate incomes, to determine whether such equipment is well adapted to the needs of the group, and to recommend possible changes in design or studies needed before such recommendation can be made, a brief survey has been made of the available literature on the subject published since 1927. This included bulletins and reports of the agricultural experiment stations, reports of committees sponsored by the electrical industry to promote rural electrification, professional and trade journals of the electrical industries in this country and England, general magazine articles, and catalogs of manufacturers of electrical ranges. A cursory examination has also been made of electrical ranges offered for sale in Washington, D. C.

Particular attention was given to equipment that might be made available at low cost to rural families in areas where cheap electrical current might be obtained if a substantial load were developed.

American Types

The American range market today offers the housewife many types and sizes of electric ranges designed and built to give efficient and reliable service over a reasonable period of time. Three general types of ranges are available: the box type, which is compact and has the oven directly below or above the surface units; the cabinet or console type, in which the oven is raised and at the side of the cooking surface; and the buffet type, a combination of these two, in which the oven and cooking surface are on the same plane but higher than in the other types. In this type the top surface of the oven may be used as a table top and the additional space below for broiler, warming oven, and utensil storage. Some ranges extend entirely to the floor and are set flush with the walls; some have adjustable legs to vary the height of the cooking surface.

Selection of a range for a given kitchen depends upon the space available and its position in relation to the windows and to other pieces of equipment. Whether the oven shall be to the right or left side is determined by the same factors. It is possible to secure a very compact "cooking unit" without legs, which can be combined with the refrigerator, sink, and storage units, and will provide a maximum of convenience and efficiency in the work areas.

The frame of the range is commonly of cast iron or welded steel, in order to provide durability and rigidity. The finish is usually porcelain enamel because of its attractive appearance, durability, and ease of cleaning. White, cream, or colored enamels are used, alone or in combination, sometimes trimmed with chromium plate, bakelite, and monel metal. The number of units required is determined by the size of the family and the amount of cooking commonly done. Some

authorities consider three burners and one oven the maximum necessary for a family of four or five. A thermal-storage well-cooker may be substituted for one of the units at an additional original cost. A convenience outlet is desirable since small appliances that contain their own heating elements are more efficient than a surface unit for the same process.

A time-control clock, which may be set to turn the current both on and off at given times, is generally available, as are automatic heat-control and heat-indicators. Most electric range ovens are heavily insulated to prevent heat losses. This contributes to the efficient utilization of current and to kitchen comfort in warm weather. Because of the large thermal mass, preheating an oven requires considerable time and electrical energy. For many cooking processes, however, the cold start has been found to be entirely satisfactory. Some ranges utilize a reflecting surface oven lining to cut down preheating time, and this results in increased efficiency.

Both open and closed surface units are in general use. The first cost of replacement of the open unit is low, and it is standard equipment on most ranges. Recent models of enclosed units combine quick heating with long life and are said to be more efficient than most open units. A combination cone-reflector on an open unit is also available. The oven heating elements are commonly placed within the oven space and thus cut down the "usable" oven area. Baffles are frequently used to insure even heat distribution, and they also reduce oven space. Provision is sometimes made for broiling directly under an oven element rather than in a separate broiling oven. Several small ovens, some requiring only an appliance outlet, are now available, and are said to be satisfactory and economical for small quantity baking.

The responsibility for the promotion of the use of electricity in the home seems so far to have been chiefly in the hands of the producers of electrical current and the manufacturers of electrical equipment. Their interest has naturally centered in equipment that would insure a power load and in developing features that have a known sales value. Much of their promotional work has been directed to stimulating the desire of the consumer to possess a piece of equipment rather than to supplying a definite and recognized need with an efficient and useful tool. As an example, a recent report of an electric range committee of an association of power companies recommends that the buffet-type range be adopted "principally because it simplifies inventory and eliminates duplication made necessary by right and left-hand models," while a minority of the committee held that women would continue to "accept" the console model for some time. Only one member considered it desirable to bring to the attention of manufacturers the need for a reduction in prices for ranges, though several recognized a need for lower prices for range parts. All agreed that a warming oven should be the first essential "sales feature" in promotional work for the next year. The committee on home appliances of this association reported that the importance of such appliances to the industry lay not in the profits from their sale or their load-building value, but because the use of small appliances familiarized women with electricity, overcame their fears, and paved the way for sales of larger equipment. It was the unanimous opinion of the committee that the time had now come to sell these appliances on the basis of "service" rather than "pride of ownership." It was pointed out that some appliances (apparently bought on this

latter appeal) were used more for decoration than for load building, and it was agreed that manufacturers who produce a "utility line" of items such as waffle irons, toasters, and percolators - mechanically entirely satisfactory, but sold at lower prices because untrimmed and "styled" - should be encouraged.

While these conclusions may be warranted by the merchandising experiences of range manufacturers, the possibilities of the mass production and sale of ranges designed to specifications based on actual cooking needs and laboratory tests of performance under household conditions have not been recognized. If ranges were built to give better performance and sell at lower prices than is now usual it would result in rapid increase in the use of electricity for cooking and would benefit manufacturers of ranges, power companies, and consumers alike. One power company has successfully demonstrated the practicability of this plan, but range manufacturers have failed to adopt it.

It seems unfortunate that in the design of electric ranges more attention has not been given to the unique flexibility of electric current as a cooking fuel, and that electric ranges continue to be patterned after those designed for coal, gas, or oil, or made to imitate other pieces of furniture, and to conceal their real purpose. For example, some recent buffet models present an entirely enclosed table top. When needed for cooking, one side lifts up and slips from the horizontal to a vertical position against the back of the range to disclose the cooking units, a hinged door drops down to reveal the switch knobs, and other drawers or cupboards are in fact warming or broiling ovens and storage spaces. Various luxurious accessories are offered - at an increased cost. Thus one new range gives the option of a built-in radio, or a small toaster-broiler in the mantle back of the range, or at a lower price, a simple toaster. This range also provides a chromium-steel ornament upon which the purchaser's three-letter monogram will be placed, and a recipe card file in the utensil drawer. A cooking top lamp and time-control clock are supplied at an additional cost.

Trends in European Ranges

In England, on the other hand, electrical cooking equipment seems frankly designed from the standpoint of efficiency and utility. Considerable attention has been given to the standardization of "cookers" (ranges), to interchangeability of parts, and to the development of models that will meet cooking needs efficiently, and will not rapidly become obsolescent. Box-type ranges, with a "hob" containing two or three surface units, often rectangular in shape, a warming oven directly beneath the hob, and the oven below that, seem to be most popular. The switches are placed along the side of the oven, probably to leave clear space below the hob for the warming oven. The preference for totally enclosed units is clearly established, as is the principle that in boiling plates speed should be balanced by reliability. The cement-fitted solidly-embedded-type unit is accepted as standard, though the necessity of developing an embedding mass that is less hygroscopic and lighter in weight is noted. Closed units are considered to offer less risk of shock than open units. The opposite opinion has been expressed by American engineers.

English ovens generally have rounded contours, are molded in one piece to prevent moisture and fat creepage into the insulation, and can be easily cleaned.

The heating elements are externally fitted into the oven walls, plugging in from the outside or back of the range. Side and bottom rather than top and bottom heating is general. One new oven has no projections inside. The ten mica-formed elements, four on each side and two for the bottom, slide into pockets welded to the insulated side of the interior. The whole oven is thoroughly insulated. The elements are standardized, interchangeable, and easily replaced. In a competitive model the elements are placed within the actual cooking space and their projection into the oven is used to support the movable shelves. Welded assembly makes the oven completely water-and steam-tight. This oven can safely be filled with water while the circuit is on.

"Breakfast cookers" are widely used. These provide a high voltage surface unit with a deflecting pan to send the heat up for boiling or down to the oven for grilling or baking. Both operations can be done at once. An additional element in the bottom of the oven provides higher oven temperatures when necessary.

The British model of a portable cooker deserves consideration. It is a circular unit, which can be used upright or on its side. The large size measures 10-1/4 by 12 inches inside, has two heats, 600 watts and 100 watts, respectively, and can be used on an appliance outlet to roast, bake, fry, boil, steam, stew, or make jam, as well as to transport the contents conveniently.

The standard finish for English ranges is light mottled grey porcelain, which is durable, easily cleaned, and the parts easily matched for replacement. The latter point is important because so much of the equipment in use is installed on the "hire" or "hire-purchase" plan.

The hire or hire-purchase plan for furthering the use of electricity has been generally accepted in Great Britain for many years. It has been shown to encourage consumers to try out new equipment, which if unsatisfactory can be returned and payment made only for its use. Experience proves that users are generally satisfied and are disposed to purchase the equipment. A report from Aberdeen, Scotland, shows 14,000 electric appliances now on hire. "It is an established policy to leave an iron on a month's free trial with every new customer, with a leaflet explaining terms and directions for use. Few irons are returned and the cost of the scheme is small compared with the revenue from the resulting sales of current." The opinion is expressed that large appliances, such as ranges and water heaters, must continue to be hired until prices are reduced or until rapid obsolescence due to improvements is further reduced. There are plants devoted entirely to reconditioning ranges used on the "hire" plan. Perhaps the adoption of this plan is largely responsible for the serious attention given in England to the standardization of ranges and parts and their marked durability and efficiency.

A very interesting type of electrical range which has been widely used both in England and on the continent is the thermal storage stove. One British stove of this type was designed for rural use where transmission costs are high or where load on distributors must be fixed. It is a compact box type, with the equivalent of two surface units, an oven 14 by 14 by 14 inches, a warming oven below, and only toe room above the floor. A cast iron block of 130 pounds provides the top cooking surface. It is bifurcated to provide two 7 by 4-1/2

inch hot plates, and is fitted with two 250-watt heating elements. The underside of the block is directly above the oven. To reduce thermal losses the block is insulated from the casing, and held in position by two chains. Space around the block is insulated with 6 inches of slag wool, with 4 inches of the same around the oven, which is made of a single piece of sheet metal. A baffle plate controls the heat transmission. A two-part hinged and balanced lid covers the cooking surface of the storage plate when not in use. The range is kept constantly in circuit with a continuous load of 500 watts. The heat generated is stored in the block, and the upper surfaces are used as hot plates, the lower to heat the oven. A 500-watt element is fitted in the base of the oven to increase the oven heat if required, but when it is in use the storage block is automatically cut out. The stove uses 12 kilowatt hours of electricity per day, which is usually supplied at a low flat rate. The cost of operation is said to be less than for stoves of the ordinary type.

A Swiss stove has also been developed to insure a steady load demand where a peak is undesirable from the power station standpoint. This is box-shaped with an iron case containing a heating element of from 450 to 600 watts maximum consumption, embedded in sand as insulation. The oven and three boiling plates are heated by circulated air passed through the electric heater and controlled by a fan. Control valves direct the hot air to the oven and surface burners as required, and it finally goes to heat a water tank built into the stove. Four degrees of heat are obtainable. Started from cold, 18 to 20 hours is required to bring the stove to full heat, and the required temperature is maintained by means of an automatic switch-off. This stove is said to give a wider range of useful temperatures than the ordinary type of stove with an increase of only 16 percent energy consumption, and it makes use of off-peak storage.

A Swedish stove, of the iron-block type, is also in use. It automatically maintains a temperature of 900°F. in the hot plate, and 190° to 200°F. in the simmering oven. There are two elements of about 350 watts each, fitted with two plugs, one or both of which may be used. The hot plate is said to become as effective as a 2,000 watt-hour surface unit. The use of heavy engine-turned aluminum cooking utensils is advocated to insure efficient heat conduction. A quart of water boils in less than three minutes. When the boiling point is reached the utensil can be raised above the plate to prevent too rapid cooking. With the low oven temperature provided, cooking should be started on the high temperature surface units (meat seared, for example) and then transferred to the oven to complete the cooking. With tightly covered utensils there is no loss of liquid and no burning. The stove can be plugged into any light socket. Diagrams of these stoves are attached.

Recommendations

This brief study of American and European types of electric ranges leads to the following observations of present practices and recommendations in regard to future developments.

Selection and arrangement.— The selection and arrangement of cooking equipment requires more careful study than is now customary. The size and type selected should be directly related to the size and standard of quality of the equipment of the rest of the house, and it should be planned and installed as permanent equipment. Designs for electrical equipment should take advantage of the flexibility of electric current and disregard present types of ranges, which

were designed for the utilization of coal, wood, gas, and oil, or made to imitate other pieces of furniture. The decentralization of cooking processes within the kitchen may prove practicable. Thus surface units might be installed in a combination table and stove with the units at the side or directly back of a shallow working surface. One unit might have but two heats, one to bring food quickly to maximum heat, the other sufficient only to maintain a simmering temperature in a covered utensil. From the point of view of time, space, efficiency, and cost, it may be more satisfactory to provide two ovens. One might have a reflecting innersurface, with light insulation, loaded to heat quickly, to be used for short baking processes when high temperatures are required; the other provided with heavy insulation, to be used for long processes or when a succession of cooking processes are anticipated. Studies might determine which oven need be larger. The baking oven might be set up in a separate work area, it might be portable or even expansible.

Storage spaces.- The present tendency to incorporate storage spaces, such as utility drawers, in the range itself, should be studied to determine the amount of space required for utensils first used on the stove itself, the availability of similar convenient space elsewhere, and the comparative cost of making such spaces useful. The amount and character of space required for warming dishes and the best means of providing it needs further study.

Surface units.- The number of surface units required for family use needs further study. Whether open or enclosed units or both are provided, depends upon the cooking processes most commonly used, the requirements for speed, high temperatures, time under operation, volume of food prepared, and the intelligence and skill of the worker. The problem of securing speed in heating seems satisfactorily solved but not always applied in practice. Enclosed units are more durable than open, but have a higher first cost and replacement cost. The ease of replacement of elements, and whether elements can be fitted by a "handy man" are important factors in determining selection. Many studies are available of the speed of heating, efficient utilization of current, heat retention, durability, and cost of the different open and closed units available. It was interesting to find in one large appliance salesroom associated with a power company, ranges equipped only with surface units which are known to utilize power inefficiently, and no effort made to acquaint customers with the availability of more efficient equipment.

Ovens.- The oven may be a part of the range or, like the English "cooker," a combination boiling plate, grill, and oven; or it might be a separate appliance. The amount and type of oven insulation and the finish of the inner and outer surfaces should be definitely related to the temperature requirements, length of cooking processes, and ventilation. The question of the amount of ventilation necessary in a baking oven and its control needs further consideration. Apparently less ventilation is required than with other fuel, and it should be adjustable. It has been pointed out that during roasting an oven must discharge between six and seven times its volume of steam at atmospheric pressure to secure effective browning without resorting to excessive temperatures. The material used for the inner surface of the oven is important. Much complaint of deterioration, rusting, and flaking is expressed. Polished surfaces that

increase oven efficiency by providing radiant heat are available. Studies may be necessary to determine whether in use foods tend to become carbonized on the metal, forming insoluble compounds which decrease the original efficiency, and to determine the amount and type of care necessary to keep the surface in condition. Smoothly rounded oven contours are said to wear better, would certainly be easier to clean, and would prevent moisture and fat creepage into the insulation. Heating elements are commonly placed within the oven space and may seriously interfere with the usable cooking space. Shields to protect the elements from spillage or spattering may interfere with good circulation of heat.

Temperature control.- Automatic temperature regulators appear to vary widely in accuracy and not to be highly sensitive to temperature changes. Their importance for economy of operation, safety to the stove through prevention of high temperatures that would warp and crack the oven and shorten its life, and as an aid in insuring suitable baking temperatures, is accepted, but further studies of performance under actual cooking conditions should be made.

Construction and finish.- Vitreous enamel is generally accepted as a satisfactory finish for ranges. Experience shows the wisdom of restricting the use of color to neutral colors. Frames should be substantial and surface units for electrical cooking should be accurately adjusted in the opening provided and rigidly fixed in the plane position since complete contact with the cooking utensil is necessary for efficient heat conduction. Units and wiring should be protected against foods boiling over and spilling on them, and should be accessible for cleaning. Individual fuses should be provided for each heating unit, with a master switch to disconnect the entire cooking load.

One or two appliance outlets on ranges are desirable and should be conveniently located, since it has been shown that appliances containing their own heating elements, such as percolators, toasters, and waffle irons, are more efficient than the use of separate units.

Name plate.- To aid the consumer in the selection of a range adapted to her needs every range should carry a name plate which states the voltage and total wattage rating of the range, the amount of usable oven space in cubic feet, the time and power required to bring the oven from 68° to 400°F., and each surface and oven unit should be plainly marked with its wattage rating.

Utensils.- When cooking with electricity is introduced into a home, it is important that suitable utensils be provided and inefficient ones removed. Since the surface heat is largely transferred by conduction, utensils that may be satisfactory for use with gas or oil are too inefficient for use on an electrical unit. With a properly plane and correctly installed surface unit the utensil also must have and maintain a plane surface and be kept smooth to insure absolute contact. Flat-bottomed specially drawn (not cast) aluminum utensils, with 1/4 inch machined bottoms, inflexible, are recommended to secure speed in heating and low consumption of current for surface cooking. Utensils should be as nearly as possible the exact diameter of the unit over which they are used. Slowness of heating may be due to loss of true surface of the element or buckling of the pan, either of which results in air gaps between the two. Improper utensils may cause scaling of the plate and shorten its life. The thermal efficiency of an aluminum pan is shown to be increased about 10 percent by a coating of black lacquer on the bottom. This finish is subject to wear but can be easily renewed. The pan bottom should not be recessed; its sides should

be straight and highly polished; a tight fitting cover should be used. Great variation has been shown in the efficiency of various materials when used for oven cooking. English stoves, particularly the "breakfast cookers," as usually sold, include an efficient tea kettle. Where stoves are "hired" rather than sold it is considered important that utensils also be hired at a nominal rental to insure the user's satisfaction with the new fuel.

General Conclusions

1. While it is obvious that the fundamental interests of producers and distributors of electrical power and electrical equipment are identical with those of the ultimate consumers and that each can reap the full benefit from the maximum use of electrical power only through the recognition and pooling of their common interests, the development and promotion of the household use of electricity up to this time has not been so motivated.

2. The sound development of the use of electrical power by the individual household in areas where power lines are available and rates satisfactory depends upon the development of equipment which is easily cared for, is durable and can be sold at a reasonable price, and is designed to perform specific and necessary functions with maximum efficiency. This implies some standardization of appliance for functional value and would tend to base competition upon price in relation to quality, and to discourage duplication and development of equipment designed primarily on the basis of sales appeal.

3. Further studies are needed to determine the amount and character of the cooking done and the size and type of utensils needed by both rural and urban families differing in size, income, dietary habits, and buying practices. Such studies should cover typical seasonal periods and should give a sound basis for determining the amount of top stove and oven space and the appliances and utensils needed.

4. The educational programs of home economists engaged in promoting the use of electrical current and equipment should be closely coordinated with those of nutrition workers to insure that cooking units and utensils recommended provide convenient and efficient means for preparing the menus and recipes recommended as adequate diets, at different income levels.

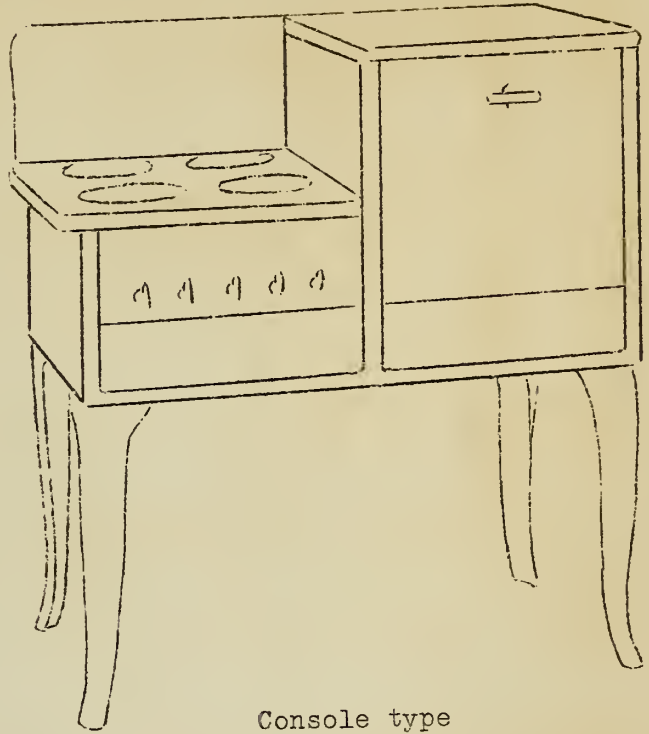
5. Studies should be made of thermal storage stoves to determine their practicability for use here in areas where a constant load factor is important, particularly for low-income rural families.

6. Whenever electricity is introduced for household use provision should be made to instruct housewives in its utilization, and in the selection and care of electrical equipment and appliances, to the end that its possibilities as a convenient, efficient, and indefatigable household servant may be fully realized.

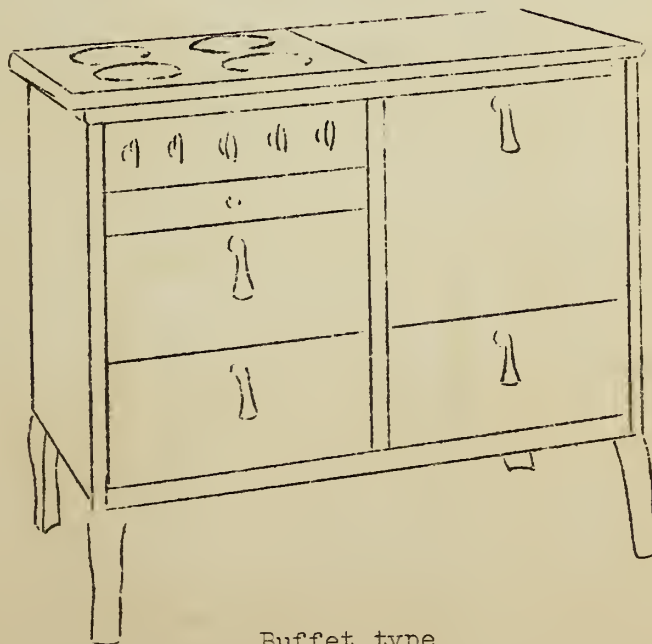
American Type Ranges



Box type

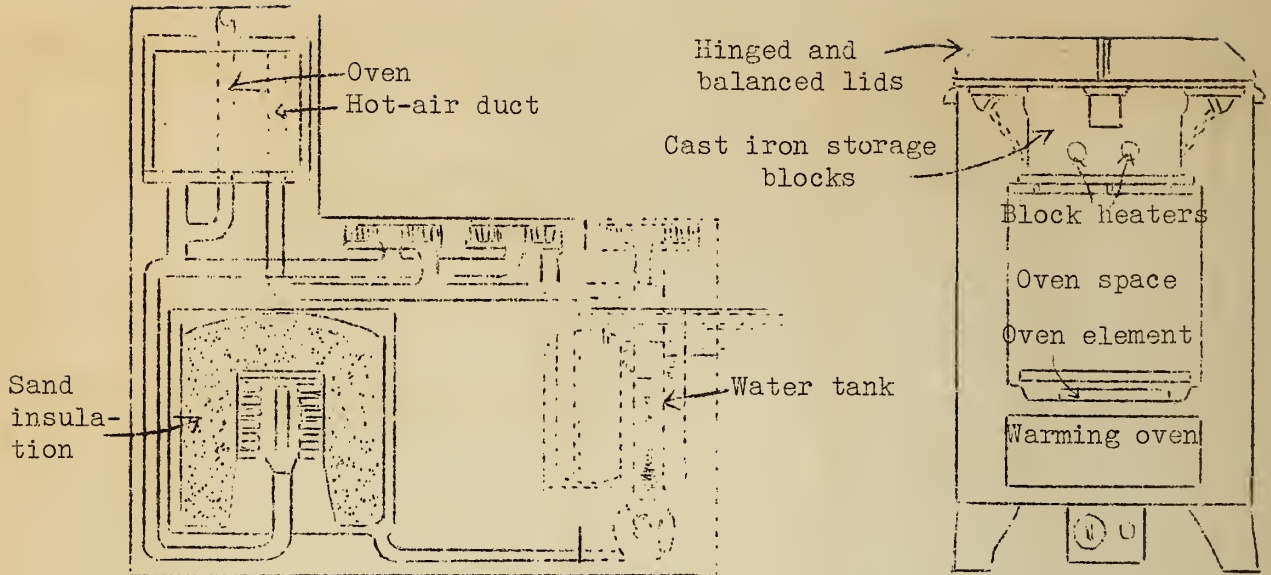


Console type



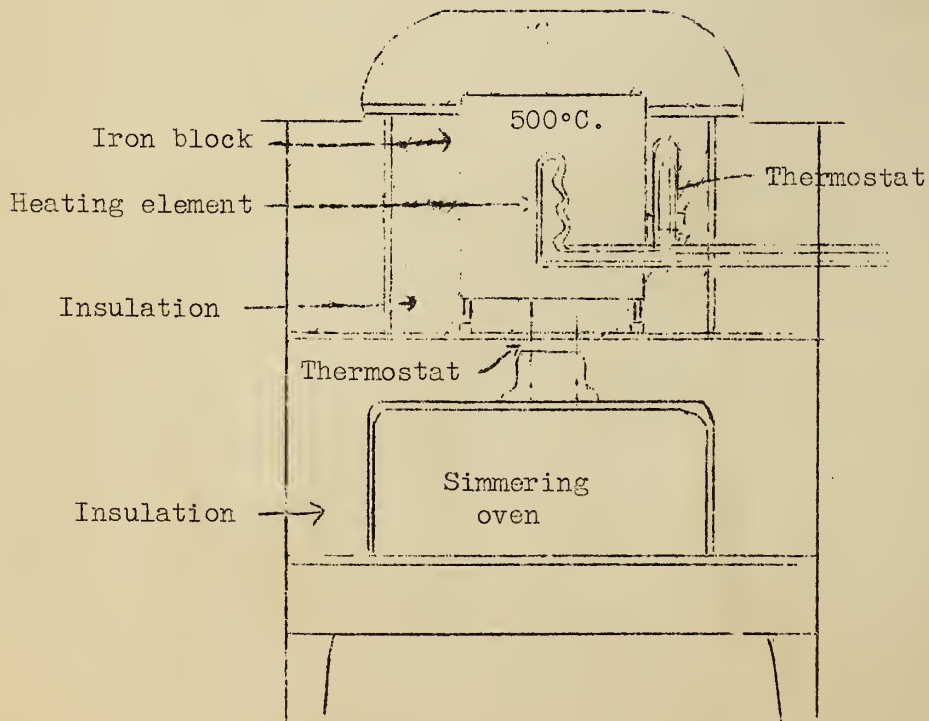
Buffet type

Thermal Storage Ranges



Swiss Therma-Seehaus cooker

English heat-storage cooker



Swedish Seves cooker